HABITAT SEGREGATION AS A FACTOR IN REDUCING INTERSPECIFIC COMPETITION AMONG SPECIES OF *LACCOPHILUS* (Dytiscidae)

By James R. Zimmerman[1]

Of approximately fifteen species of *Laccophilus* known from the United States, four have been reported from Indiana. These small aggressive beetles have habits and habitats similar to that of many other members of the family Dytiscidae or predacious diving beetles. Some species of *Laccophilus* can be collected from almost any pond or stream in Indiana. During September and October hundreds can usually be taken in a short time in a favorable situation.

Three species, *Laccophilus maculous* Say, *Laccophilus fasciatus* Aubé, and *Laccophilus proximus* Say, occur in nearly every if not all counties in the state, but a fourth, *Laccophilus undatus* Aubé, has been reported from only a few separated localities in Lake, Laporte, Tippecanoe, and Monroe Counties. All four species have been taken in the same pond in Monroe County near Bloomington. In a few instances, three, and even four species have been taken in a single dip of the collecting net.

The species can be readily distinguished from one another in the field on the basis of size, coloration, and elytral pattern. In size they range from largest to smallest as follows: *maculosus* from about 5.5 to about 5.0 mm; *fasciatus* from about 5.0 to about 4.5 mm; *proximus* from about 4.5 to about 4.0 mm; and *undatus* from about 4.3 to about 3.8 mm.

Laccophilus species can be found most commonly in shallow water along the margins of ponds, sloughs, and streams in water less than one foot deep. Some occur in streams in other regions, but *fasciatus* seems to be the only Indiana species commonly found in running water. Vegetation, rocks, debris, and algal mats serve as cover and points of attachment. The beetles are buoyant due to the air bubble which is carried beneath the elytra and sometimes extruded at the tip of the abdomen, and thus swimming effort or attachment to some heavier or fixed object is required in order for them to stay beneath the surface.

Laboratory observations indicate that all four species feed on the same prey organisms. Since these animals utilize the same prey and are found in the same habitats, it is assumed that they compete against one another. According to Gause's rule, two species (or more) can not persist in the same microcosm if they have the same food requirements. The species of *Laccophilus* do persist in the same habitat, but it is unlikely that they have identical requirements. Adults, at least, may be found

[1]Indiana Central College, Indianapolis, Indiana.

together frequently, but there may be a more distinct segregation in the case of the voracious larvae.

In order to determine some of the factors affecting their interrelationships, collections were made in certain ponds in Monroe County, Indiana, for a period of about 14 months from 1955 to 1957. Collections were made at about two-week intervals to try to detect changes which might occur in adult populations. Considerable fluctuations in numbers were found in all four species of *Laccophilus*. The details of this study will be reported elsewhere. In summary, all show the following pattern: A high population level in early spring—in March, followed by a striking decline which reaches a low in June. This decline is a mortality curve of the adults of the previous year. Then a gradual increase of emerging adults (tenerals) through the summer and early fall, and finally a decrease with the onset of cold weather. The beetles apparently begin hibernation at this time, but a few individuals can be found all winter. The place and mode of hibernation has not yet been established.

For much of the year few habitat preferences can be detected among the four species. But in the late summer and early fall when the populations become heavily concentrated through the gradual increase in numbers and also through the decrease in available habitat, some segregation into different parts of a single situation is indicated. In order to test this, samples were taken from two ponds on August 30 and from another on September 21. The collections were made in such a way that two categories were represented as follows:

(1) specimens collected along the extreme margins of the ponds in water an inch or less in depth, and

(2) specimens collected in the deeper central portion of the ponds where the water was up to 12 inches in depth.

The collecting effort was equal in the two localities. The ponds were relatively similar in each case with debris, but little vegetation at the margin, and considerable vegetation, principally *Ludwigia*, in the middle. *Ludwigia* is a fleshy plant common in ponds and ditches which dry up in the latter part of the year.

The results of sampling these three ponds is summarized in Table 1.

The differences in frequencies found for *fasciatus, proximus,* and *undatus* are statistically significant by the Chi Square Test. The data for *maculosus* showed no statistical significance in these ponds, but they suggest that there might be some preference for the middle over the marginal area of a pond. Recent collecting in other geographical areas tends to bear this out.

I believe that these data demonstrate that *fasciatus* and *proximus* usually occur on the extreme edge of ponds and that *undatus* is largely confined to the middle in deeper water among submerged plants.

A possible explanation of this segregation may be a preference for a warmer or cooler temperature. The temperature readings were 3 to 4 degrees centigrade higher in the surface water than six inches beneath.

Young and Zimmerman (1956) report that in Indiana *fasciatus* and *maculosus* are not found in the shallows of ponds at times of the day when the temperature at the surface approaches 40 degrees centigrade.

TABLE 1. SAMPLING RESULTS TO TEST HABITAT SEGREGATION IN *LACCOPHILUS*

	Pond A 8/30/56		Pond B 8/30/56		Pond C 9/21/56		
Species	*edge*	*mid*	*edge*	*mid*	*edge*	*mid*	x_2 *value*
undatus	2	26	2	8	2	16	17.29
proximus	17	8	9	0	18	3	9.14
fasciatus	40	4	20	2	60	45	13.44
maculosus	1	4	1	1	4	7	1.00

They tend to concentrate under sticks and floating vegetation or burrow into the bottom. Conversely, in the early morning and at night they can be found foraging at random in the shallows.

Another explanation may involve the amount of vegetation present in the middle of these three ponds and the general absence of vegetation in the margins. *L. undatus,* if present, was nearly always found in thick, submerged vegetation. This is often true of *maculosus,* but on occasion, *maculosus* is found in large numbers in situations almost completely free of submergent plants.

In summary, these data suggest that one way in which inter-specific competition among sympatric species can be minimized at critical times of the year when available habitat is at a premium is by differential habitat occupancy. At seasons of the year when concentration is not so great each species can then utilize less restricted areas.

Literature Cited

Young, F. N., and J. R. Zimmerman. 1956. Variations in temperature in small aquatic situations. Ecology. 37:609-611.